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ENERGY AND SUSTAINABLE DEVELOPMENT: DEVELOPMENT OF ENERGY RESOURCES IN DEVELOPING COUNTRIES

Energy exploration and development trends in developing countries

Report of the Secretary-General

SUMMARY

Improving the quality of life is a central development objective of developing countries. The very difficult situation in these countries is to a large extent associated with very low consumption of energy. To foster economic growth in order to improve the welfare of their people, developing countries must expend more commercial energy.

Fossil fuels, particularly oil, continue to dominate, and will do so in the foreseeable future, in the energy demand structures of both developed and developing countries; and, for the vast majority of developing countries, the fact that the oil is imported accounts for a large share of their imports. Growth in commercial energy demand has continued strongly in most regions of the developing world and the projected increase in demand for commercial energy and the rapidly growing need for additional electricity-generating capacity will place formidable investment requirements on developing countries, at a time of contraction in multilateral loans and grants and official development assistance in the energy sector. Moreover, private

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investment in this sector may prove difficult to secure for many developing countries because of all the non-regulatory constraints, such as poor infrastructure and macroeconomic conditions.

The present report presents an update of the review of energy exploration and development trends in developing countries contained in the previous report on the subject (E/1994/75) and discusses those countries' energy situation and needs.

Renewable energy technologies have enormous potential but realizing the potential still requires significant research, development and demonstration in developing countries. Despite the optimistic outlook for and rapid growth of many renewable energy technologies, in the near term none of the renewable energy sources are likely to repeat the phenomenon of nuclear power's penetration over the past 20 years of the world energy demand structure. Biomass, mostly fuelwood, continues to contribute significantly to the energy mix of many developing countries. Inasmuch as biomass resources are important to these countries, strategies to enhance the resource base must be planned with the larger developmental context in mind.

Economic development in developing countries must accelerate to meet the needs for an improved quality of life of their growing population. Economic and social progress require increased commercial energy consumption and therefore developing countries are concerned about having secure and affordable sources of commercial energy. Thus, any new and additional supply from indigenous energy resources will contribute much towards realizing the aspirations of developing countries.

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Abbreviations and symbols used

b/d	barrels per day
boed	barrels of oil equivalent per day
kgoed	kilograms of oil equivalent per day
KWh	kilowatt hour
m^3	cubic metre
Non-OECD Europe	Eastern Europe and the former Soviet Union (the text specifies whenever the Central Asian republics are considered separately from this group of countries)
OECD	Organisation for Economic Cooperation and Development (for the purposes of this report, Mexico is discussed under the regional group for Latin America)
OPEC	Organization of the Petroleum Exporting Countries
toe	tons of oil equivalent
TWh	terawatt hour

INTRODUCTION

1. The Economic and Social Council, at its resumed substantive session of 1994, took note of the report of the Secretary-General on energy exploration and development trends in developing countries (E/1994/75) of 16 June 1994 during its deliberations on energy matters under the agenda item Economic and environmental questions. It was pointed out in the report (para. 92) that the General Assembly in its resolution 45/209 had welcomed the outline of a programme of action for the acceleration of energy exploration and development in developing countries contained in an earlier report on the same subject (A/45/274-E/1990/73 and Corr.1), and again emphasized in a subsequent report (A/47/202-E/1992/51) submitted to the Assembly at its forty-seventh session through the Council.

2. Very few of the objectives outlined in the above reports, which have been endorsed repeatedly by the General Assembly, have been achieved, especially in the energy-deficient developing countries. In the above-mentioned report (E/1994/75) to the Economic and Social Council, it was recommended (para. 94) that the Council request the Committee on New and Renewable Sources of Energy and on Energy for Development to provide advice and recommendations for further consideration by the international community and the United Nations system, especially with regard to the main elements and objectives of a programme of action. However, owing to time constraints, the Committee on New and Renewable Sources of Energy and on Energy for Development, at its special session in 1995, postponed consideration of the item on development of energy resources in developing countries and consequently requested the United Nations Secretariat to prepare an update on the report on energy exploration and development trends in developing countries for consideration at its second session.

3. The present report should be read in conjunction with the previous report (E/1994/75) which presented a statistical review of energy exploration and development trends in developing countries. The direction of those trends during the intervening period is tracked in this report, including an attempt to highlight the energy situation and needs for sustainable development in developing countries on the basis of real problems faced today by the developing world.

4. Improving the quality of life is the primary development objective of developing countries. The major problem to be overcome is that of poverty (and the attendant dreadful living conditions that degrade the human spirit). Combating poverty in developing countries requires sustained economic growth which will require a corresponding increase in the consumption of commercial energy. 1/

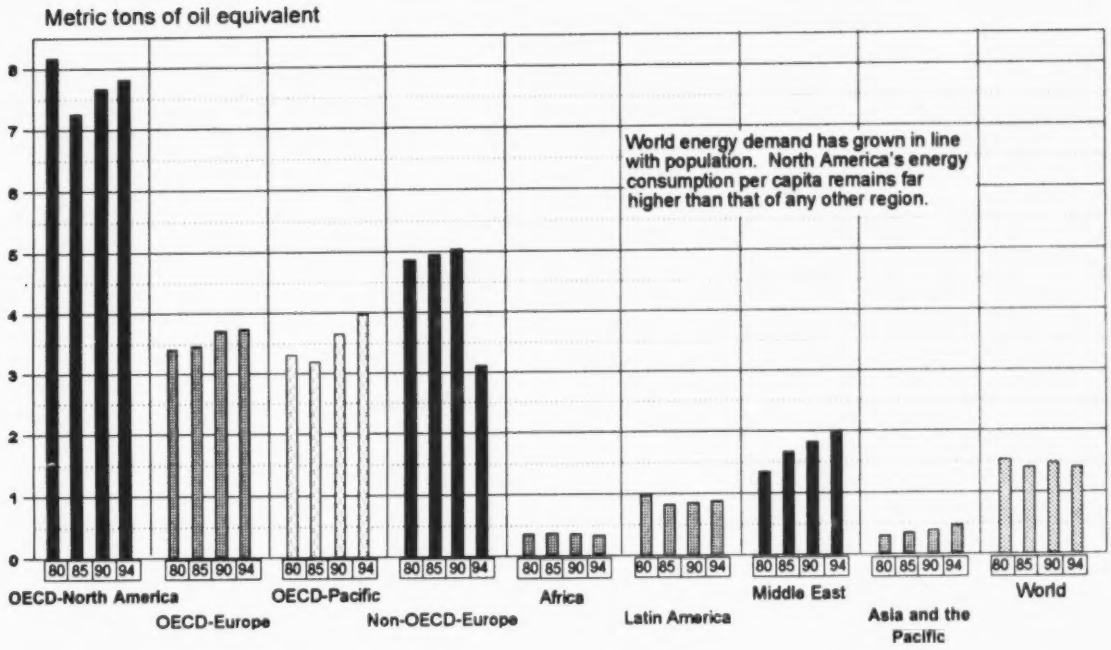
I. ENERGY NEEDS FOR SUSTAINABLE DEVELOPMENT IN DEVELOPING COUNTRIES

5. The vast majority of the people in developing countries live in rural areas, with daily nutritional intake below basic requirements, high infant mortality rates, shorter life expectancy than that in industrialized countries and limited or no access to safe water and sanitation. Moreover, the women and children among them face a daily health hazard in part from traditional fuels widely used for cooking and water-heating, since the smoke from primitive stoves is laden with carcinogens. Perhaps 80 per cent of global exposure to particulate air pollution occurs indoors in developing countries and a disproportionate share of exposure to this serious health hazard is borne by women who do the cooking and by children who are indoors with their mothers. 2/ This extremely difficult situation in the developing world is to a very large extent the result of relatively low consumption of modern commercial energy. Per capita consumption of commercial energy in developing countries is one tenth of that in Organisation for Economic Cooperation and Development (OECD) countries; in the Sahel region it is about 3 per cent of that in OECD countries.

6. Economic growth in developing countries must accelerate to meet the demands of their growing population. Economic and social development require increased commercial energy consumption as is clearly illustrated in the industrialized nations; thus, in the process of development in developing countries, a departure from this pattern is not expected. Given the arguments and controls for sustainable development, ways must be found for developing countries to achieve economic well-being and environmental protection at the same time. As they seek to industrialize, raise living standards and accommodate population growth, developing countries must expend more energy (see figure I).

7. A much-needed increase in productivity of rural areas of developing countries, in terms of agricultural output and processing, would require supplies of efficient, modern fuels for mechanized agriculture, rural transport and operating of essential tools and machineries. Liquid fuels, such as petroleum products, are easy to transport and versatile in use and at all scales of operation and thus play an important role in the rural energy sector of developing countries, as well as in the high rates of farm productivity in industrialized countries. The distribution system for petroleum products plays a key role in rural areas, as human habitations are scattered and transport infrastructure is frequently inadequate. Thus, an essential component of any strategy for rural development is to provide assistance in getting liquid fuels to rural areas.

Figure I. Commercial energy consumption per capita, by country group or region, 1980-1994



Source: Department for Policy Coordination and Sustainable Development of the United Nations Secretariat, based on Energy Statistics Yearbook (United Nations publication), various issues; and BP Statistical Review of World Energy, June 1995.

II. THE ENERGY SITUATION IN DEVELOPING COUNTRIES

8. Although growth in demand for primary energy will vary from one part of the world to another over the next couple of decades, most of the growth in demand will occur in developing countries, where, population growth rates being high, economic growth must accelerate to meet the needs of larger populations. As industrialization proceeds in the dynamic developing economies and middle-income developing countries, rising standards of living and rapid urbanization will contribute to strong growth in electricity demand and petroleum consumption will rise from an increase in private motor transport. Transportation constitutes the largest and most rapidly growing sector in the energy demand structure of developing countries.

9. If current trends persist, developing countries are expected to consume as much energy in 10-15 years as the industrialized countries do today. However, projections of economic and social conditions indicate that in a large number of developing countries, especially among the least developed countries, the standard of living will lag even further behind than it does today. 3/

10. Despite the promise of energy-efficient technologies and advanced materials science, significant increases in commercial energy consumption will be vital for real economic growth and social advancement in developing countries. To achieve even modest levels of economic growth in developing countries will require, regardless of how efficiently energy is produced and used, per capita consumption levels that are multiples of what they are today. Developing countries, particularly the energy-deficient countries, must come to grips with the challenge of ensuring adequate, affordable and secure energy supply so as to sustain development. As far as the energy-deficient developing countries are concerned, to meet this challenge and to arrest their ever-increasing dependence on imported energy, mainly oil, it will be necessary to accelerate exploration and development of indigenous energy resources and to develop greater capacity for producing commercial primary energy: oil, natural gas, coal, hydropower and other new and renewable sources of energy.

11. Most regions of the developing world have high energy resource potential, but too many of the developing countries face major financial constraints in developing these resources. The debt burden and often poor economic prospects of many developing countries further exacerbate financing problems, making it difficult to raise private investment. Nevertheless, developing countries will require substantial investments considering that their total primary energy demand will continue to grow; and even though the demand is expected to moderate, the outlook, as mentioned above, projects that, in a couple of decades, their total primary energy consumption may account for one half or more of global consumption. The increasing demand for commercial energy, the need for infrastructure to transport the energy supply and the rapidly growing need for additional electricity generating capacity will place formidable investment requirements on developing countries.

12. Also, exploration and development of indigenous energy resources, as well as their transformation into usable energy products, require massive investments, which can only be met through mobilization of financing from various sources: national private and public sources, increased access to

international capital markets, foreign direct investments, and expansion of bilateral and multilateral assistance programmes. 4/

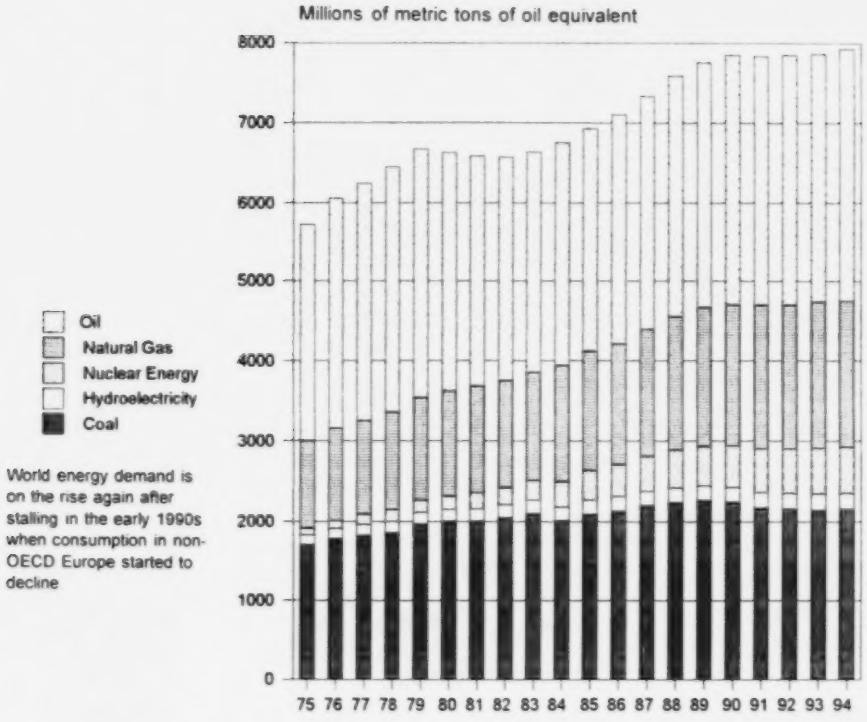
III. WORLD ENERGY DEMAND AND SUPPLY

13. World energy demand rose in 1994, up by almost 1 per cent over the previous year, after three years of static energy consumption once demand in non-OECD Europe had started to decline. The total global primary energy demand in 1994 was about 7,923.8 million tons of oil equivalent (toe) (about 158 million barrels of oil equivalent per day (boed)) (figure II). Although the share of oil in world energy demand has been steadily declining since the early 1970s, mainly as a result of oil substitution and energy efficiency measures in OECD countries, it remains the world's most important commercial fuel, accounting for almost 40 per cent of the energy market. Its continued dominance is largely due to the increasing demand for transportation fuels. Global oil demand in 1994 increased by 1.7 per cent and if non-OECD Europe was excluded it was up by 3.2 per cent. Growth continued strongly in most regions of the developing world, up 1.5 per cent in Africa and over 4 per cent in Latin America and the Middle East; and in Asia and the Pacific growth increased by 6 per cent. 5/

14. As for other major commercial fuels, world consumption of natural gas declined marginally in 1994, mainly owing to the sharp drop in demand of about 7.6 per cent in the republics of the former Soviet Union; otherwise the demand in the rest of the world continued to grow by about 3 per cent. After four years of falling consumption, world coal demand gained modestly, about 0.5 per cent and again outside of the former Soviet Union it grew by 2 per cent. China remained the largest consumer of coal followed by the United States of America, which together produce and consume half the world's coal output. Nuclear energy consumption continued to grow, though less rapidly than in the 1970s and 1980s, and was at a historically high level in 1994 accounting for 7.2 per cent of all primary energy, while the share of hydroelectricity generation remained steady at 2.5 per cent. On a regional basis, coal remains the dominant source of energy in Asia and the Pacific, mainly owing to its heavy use in China and India, while oil and natural gas accounted for most of the demand in all other regions (see figure III).

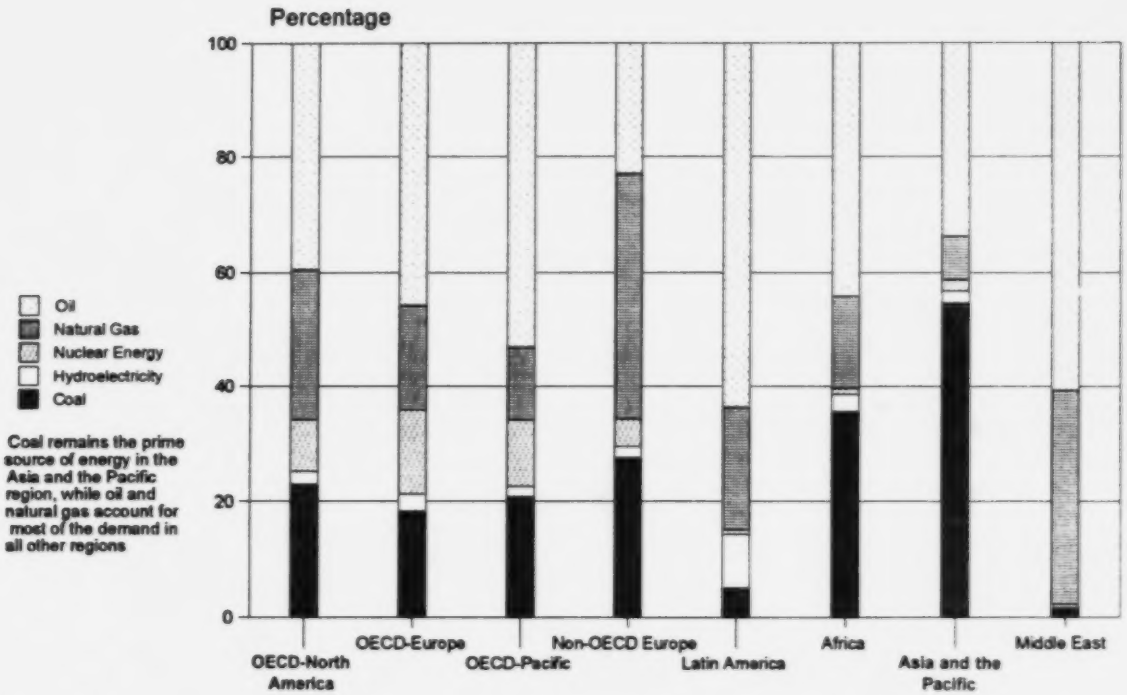
15. Throughout this decade, oil and natural gas will supply over 70 per cent of the growth in energy demand. Owing to price competitiveness and the growth in supply capacity providing more potential for prices to go downwards than upwards as well as the lack of competitive, non-petroleum alternatives for transportation fuels, oil and gas will remain the fuels of choice during this decade. During the period 1983-1990, energy demand increased by about 27 million barrels of oil equivalent per day (boed) and oil captured about 25 per cent of the new energy markets. As shown in figure IV, energy demand through the end of the century is forecast to grow by 30 million boed with oil and natural gas supplying most of the growth, 38 per cent and 35 per cent, respectively.

Figure II. World consumption of primary energy, 1975-1994



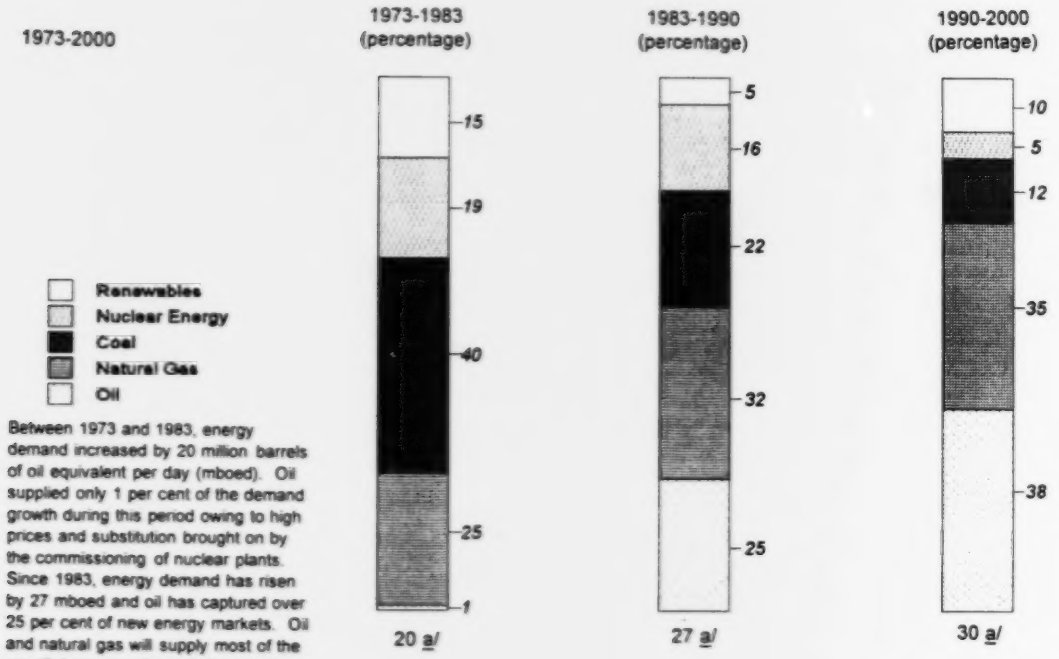
Source: Department for Policy Coordination and Sustainable Development of the United Nations Secretariat, based on Energy Statistics Yearbook (United Nations publication), various issues; and BP Statistical Review of World Energy, June 1995.

Figure III. Regional consumption pattern by fuel, 1994



Source: Department for Policy Coordination and Sustainable Development of the United Nations Secretariat, based on BP Statistical Review of World Energy, June 1995.

Figure IV. Incremental world energy supply, 1973-2000


1973-2000
1973-1983 (percentage)
1983-1990 (percentage)
1990-2000 (percentage)
Renewables
Nuclear Energy
Coal
Natural Gas
Oil
15
19
40
25
1
5
16
22
32
25
10
5
12
35
38
20 a/
27 a/
30 a/
Between 1973 and 1983, energy demand increased by 20 million barrels of oil equivalent per day (mboed). Oil supplied only 1 per cent of the demand growth during this period owing to high prices and substitution brought on by the commissioning of nuclear plants. Since 1983, energy demand has risen by 27 mboed and oil has captured over 25 per cent of new energy markets. Oil and natural gas will supply most of the growth in energy demand through the end of the century.

Source: Department for Policy Coordination and Sustainable Development of the United Nations Secretariat, based on Energy Statistics Yearbook (United Nations publication), various issues; and report of the Secretary-General on changing global energy patterns (E/C.13/1994/2).

a/ Millions of barrels of oil equivalent per day.

16. In most developing countries, oil accounts for the predominant share by far of commercial primary energy consumed. Among the energy-deficient developing countries, only 17 of them produce some of their oil requirements from indigenous resources. The remaining countries - over 100 - have no domestic oil production. Moreover, 85 per cent of the total oil produced in those countries as a whole came from just two producers, Brazil and India, and the remainder of the output was largely from a few smaller producers, Chile, Cuba, Pakistan, the Philippines and Thailand.

17. The outlook is for fossil fuels to continue to be pre-eminent in the global energy mix and to account for over 85 per cent of world energy consumption by the year 2010. Despite the rapid growth of many renewable energy technologies, no renewable energy technology is likely to repeat the phenomenon of nuclear power's penetration over the past 20 years. Oil will remain the single most important primary energy source, although its share in the world energy mix will be a declining one. The volume of oil consumed will continue to increase and by 2010, oil demand could exceed 85 million barrels per day (b/d). Of this world demand, more than 50 per cent will be supplied by six major producers of the Organization of the Petroleum Exporting Countries (OPEC), Saudi Arabia, the Islamic Republic of Iran, Iraq, the United Arab Emirates, Kuwait and Venezuela (see figure VI for the status of their current proved oil reserves). 6/

18. Also, natural gas demand will increase significantly, considering the restructuring under way in the energy industry and the technological and environmental factors that will make it the fuel of choice, especially for electricity generation. This will lead to a sharp expansion in the global gas trade, by both pipeline and seaborne liquified natural gas (LNG), which for some supplier countries means their revenues from gas export will exceed those from oil. International trade in coal is expected to double by 2010, and thus will require expansion of infrastructure for its transportation and export. Through a combination of interfuel competition, their potential to replace other internationally traded energy forms and the subsequent rise in their international trade, natural gas and coal are expected to increasingly influence the world energy market.

19. Electricity is accounting for an increasing share of final energy demand world wide and this trend is set to continue, especially in developing countries. World wide, fossil fuels have continued to be the dominant primary energy source for electricity generation, with coal accounting for the major share and likely to remain so well into the next century, although hydro and nuclear energy have made tangible progress in many countries. Hydroelectric power has reached a mature state of development in OECD countries, while in the developing world there remains a huge potential for further development, as seen in figure V; but concerns about environmental impacts and land requirements for reservoirs have constrained hydropower development in developing countries. Hydropower and nuclear energy are the only existing electricity generation options with large economies of scale that are relatively free of green-house gas (GHG) emissions. 7/ Electricity generation based on other renewable energy technologies has good potential but still requires significant research and development for commercialization, especially in developing countries.

Figure V. Extent of development of world hydropower resources

(Net exploitable in terawatt hours per year (TWh/yr) and percentage exploited)

Source: Department for Policy Coordination and Sustainable Development of the United Nations Secretariat, based on Energy Statistics Yearbook, 1992 (United Nations publication, Sales No. E/F.94.XVII.9); and Renewable Energy Resources: Opportunities and Constraints, 1990-2020 (London, World Energy Council, September 1993).

IV. ENERGY RESOURCES DEVELOPMENT

A. Crude oil

20. The vast improvement in the upstream fiscal environment in developing countries, through the liberalization of laws against foreign investment in the energy sector in virtually all countries and privatization over the past few years, has accelerated the pace of development of energy resources, particularly oil, with more offerings to international oil companies than ever before. It is noteworthy that the observed expansion in these countries is more a matter of opportunity than of geology, as their hydrocarbon potential has been proved. In the period 1976-1985, almost 90 per cent of the increase in oil production outside of OPEC and the former Soviet Union occurred in 10 countries, namely Brazil, Canada, China, Egypt, India, Malaysia, Mexico, Norway, the United Kingdom of Great Britain and Northern Ireland and the United States. Only four of these countries remain on the list of top producers after 1985 (see table 1). The others were replaced by new producers, all developing countries such as Angola, Colombia, Oman, Papua New Guinea, the Syrian Arab Republic and Yemen, and all having offered attractive terms to foreign investors for upstream exploration and development. 8/

21. More than 76 per cent of the world's proved crude oil reserves are in OPEC countries (see figure VI) and about 82.5 per cent of those reserves lie with the Persian Gulf producers. Saudi Arabia alone accounts for more than a quarter of the world's reserves and a third of OPEC reserves. The reserves-to-production (R/P) ratio in OPEC is almost double that of the world's average, and at the 1994 production rate the world's proved oil reserves would be sufficient to meet demand for the next 43 years. However, R/P ratios can be misleading, as all oil field reserves decline as they are being depleted. A depletion rate, annual production as a percentage of reserves at the end of the preceding year, may be a better measure of security of supply. In 1994, depletion of the world's oil reserves was balanced by additions from new discoveries and higher recovery rates from existing fields. Notable additions took place in Angola, Argentina and Colombia.

22. World crude oil and natural gas liquids (NGL) production in 1994, estimated at about 66.7 million b/d (excluding synthetics), was up 0.9 per cent over the previous year. Of this, OPEC countries supplied some 25.2 million b/d, about 38 per cent of the world's total. Saudi Arabia remains OPEC's largest producer, averaging 8.965 million b/d in 1994, accounting for about 36 per cent of the total production of OPEC countries.

Table 1. Comparison of the top 10 oil producers for incremental production outside of OPEC and the former Soviet Union, 1976-1995

Rank	1976-1985	1985-1993	1993-1995
1	United Kingdom	Norway	United Kingdom
2	Mexico	China	Norway
3	China	Canada	Mexico
4	United States	Syrian Arab Republic	Canada
5	Egypt	Colombia	Colombia
6	Norway	Angola	Yemen
7	India	Oman	Angola
8	Brazil	Malaysia	Argentina
9	Malaysia	Yemen	Ecuador
10	Canada	Papua New Guinea	Syrian Arab Republic

Source: Department for Policy Coordination and Sustainable Development of the United Nations Secretariat, based on Global Oil Report, vol. 6, No. 1 (United Kingdom of Great Britain and Northern Ireland, Centre for Global Energy Studies, 1995).

23. As shown in table 2 and figure VII, the share of total world oil production of non-OPEC oil exporting developing countries continues to increase, with a share of over 20 per cent at the end of 1994, up significantly from about 12 per cent at the end of 1980. In the Middle East, oil output rose, mainly as a result of new fields coming onstream in Oman, the Syrian Arab Republic and Yemen. In Asia and the Pacific, Malaysia's output has been increasing substantially and Viet Nam, where oil production was nominal a few years ago, has joined the ranks of oil exporters and a significant increase in production capacity is well on its way. In Papua New Guinea, where oil production and export began in the latter half of 1992, output in 1994 of about 120,000 b/d, declined by about 4 per cent compared with the previous year.

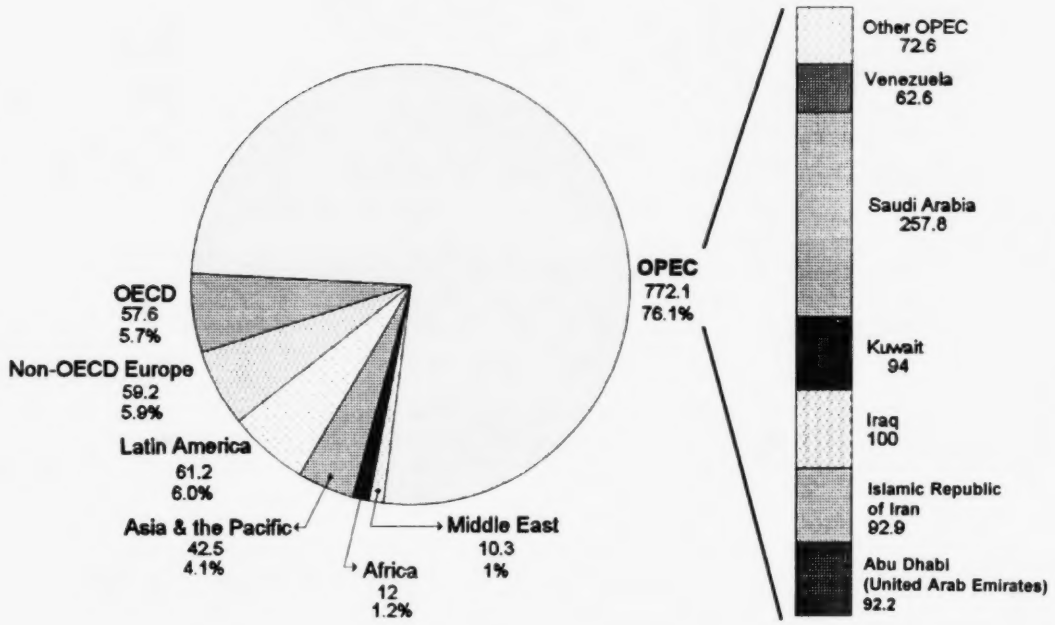
24. In 1994, oil production among Latin American oil exporters saw significant year-on-year increases in Argentina, Ecuador and Trinidad and Tobago. The biggest increases in non-OPEC production are anticipated from Latin America, where a wave of privatizations over the past few years has accelerated development. Major changes have occurred in Argentina, where the private sector now accounts for about half of oil production. Similar initiatives in Ecuador and Peru are also expected to significantly boost those countries' oil production. Oil output in Colombia, an oil importer only a decade ago, has more than tripled since 1980 to about 460,000 b/d and is expected to rise substantially.

Figure VI. Proved world oil reserves and their regional distribution

(Billions of barrels and percentage)

Distribution of oil reserves
(At 1 January 1995)

Total proved reserves: 1,015 billion barrels



Source: Department for Policy Coordination and Sustainable Development of the United Nations Secretariat, based on Oil and Gas Journal, 26 December 1994.

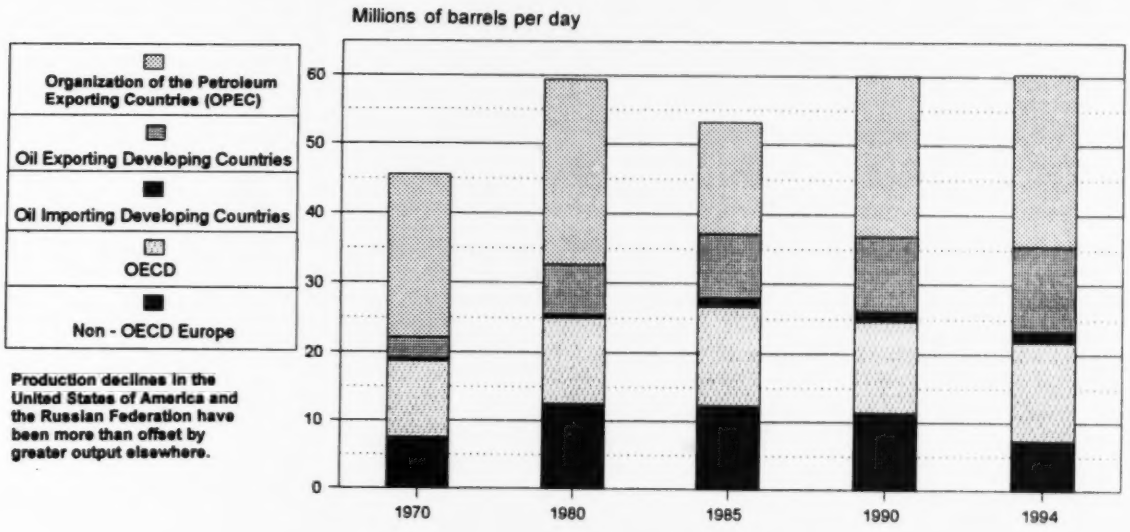
Table 2. World crude oil production by country group, 1970-1994

(Millions of barrels per day)

Country group	1970	1980	1985	1990	1994
OPEC countries	23.31	26.73	16.08	23.25	24.94
Share of world total (percentage)	51.2	45.0	30.2	38.7	41.3
Oil-exporting developing countries	3.06	7.17	9.06	10.62	12.13
Share of world total (percentage)	6.7	12.1	17.0	17.7	20.1
Oil-importing developing countries	0.42	0.51	1.38	1.57	1.56
Share of world total (percentage)	0.9	0.9	2.6	2.6	2.6
OECD countries	11.24	12.57	14.36	13.32	14.48
Share of world total (percentage)	24.7	21.1	27.0	22.2	24.0
Non-OECD European countries	7.47	12.45	12.32	11.34	7.28
Share of world total (percentage)	16.4	21.0	23.2	18.9	12.0
World total	45.5	59.43	53.2	60.1	60.39

Source: Department for Policy Coordination and Sustainable Development of the United Nations Secretariat, based on Energy Statistics Yearbook (United Nations publication), various issues; and Oil and Gas Journal, 26 December 1994.

Figure VII. World crude oil production by country group, 1970-1994



Source: Department for Policy Coordination and Sustainable Development of the United Nations Secretariat, based on Energy Statistics Yearbook (United Nations publication), various issues; and Oil and Gas Journal, 26 December 1994.

25. The situation is similar in Africa. Oil production in Angola and the Congo has also increased more than threefold since 1980, while Chad, upon completion of a 650-mile crude oil pipeline to a marine terminal on Cameroon's Atlantic coast, but with no history of oil production, will none the less soon be joining the ranks of oil exporters. Chad's productive capacity is pegged at 150,000-250,000 b/d. Although the existence of oil reserves in the Sudan had been pinpointed in the early 1980s, oil production could begin only in 1992, at about 1,000 b/d increasing to 2,000 b/d the next year, as exploration and development activities had been hindered by civil war.

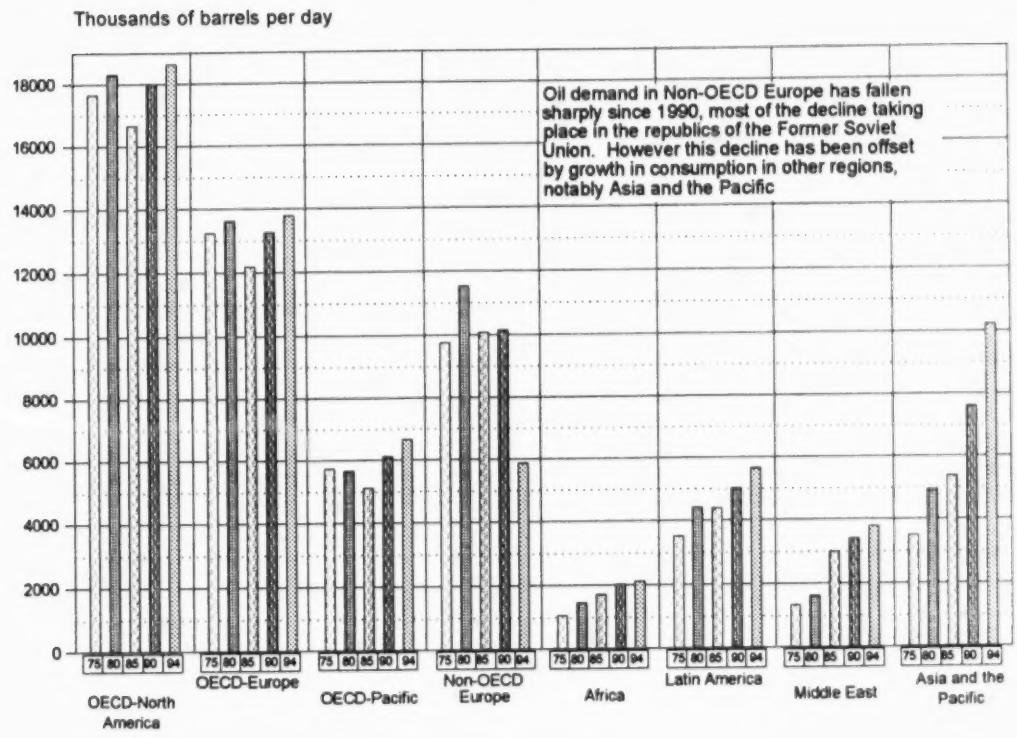
26. As mentioned above, the bulk of the oil output from energy-deficient developing countries comes from a few producers, with Brazil and India accounting for 85 per cent of the total. India's oil production dramatically increased by 15.5 per cent in 1994, to about 715,000 b/d. After showing substantial gains during the past decade, India's oil output has been registering a steady decline from peak levels in 1989. Improvements in the upstream fiscal regime would enable India to continue to expand its oil output. Brazil continues to make steady gains in its oil production, having posted an increase of 3.8 per cent in 1994; with significant deep-water discoveries and with the opening up of upstream investment, further gains in its oil output are expected. However, the share of the energy-deficient oil producing developing countries in total world oil production has remained stagnant at about 2.6 per cent for the past decade (see table 2).

27. In the non-oil producing developing countries, exploration activities remained at very low levels, despite promising geologic prospects in a number of these countries. In 1992-1993, in Africa, seismic surveys continued in Ethiopia, Madagascar and Namibia where offshore licensing attracted significant activity. Five exploratory wells were also completed in Madagascar in 1992-1993, all reportedly testing dry. In Latin America, Paraguay was the only country with any exploration activity, having had some land seismic surveys conducted. In Asia and the Pacific, notably, onshore seismic lines were produced in Cambodia and the Lao People's Democratic Republic, where exploration activities had not been observed before.

28. Over the next few years, the competition for investment in non-OPEC countries will intensify; and Governments of developing countries must realize that, in an environment of weak oil prices, they need to create more attractive fiscal and legal regimes if they are to finance the investment necessary to sustain and expand their domestic oil production.

29. In 1994, world oil demand was more or less in balance with supply. Of the total demand, OECD countries accounted for 58.6 per cent and, developing countries for 32.6 per cent, with the remainder derived from non-OECD Europe (see figure VIII). In the developing world, the strongest growth was in the Pacific rim countries and parts of Latin America. The largest end-use sector for oil was transportation, which accounted for about half of total demand. In OECD countries, the transport sector consumed 80 per cent of petroleum products with private motor cars responsible for 75 per cent of road traffic consumption. In developing countries, on average, transport consumes about 46 per cent of petroleum products and those countries' road transport tends to have a relatively higher proportion of diesel vehicles such as buses and trucks. 9/

Figure VIII. Oil consumption by region, 1975-1994



Source: Department for Policy Coordination and Sustainable Development of the United Nations Secretariat, based on Energy Statistics Yearbook (United Nations publication), various issues; and BP Statistical Review of World Energy, June 1995.

30. World-wide petroleum exploration and development activities on average remain stable, although in developing countries some of those activities continue to decline. In the past two years, a few developing countries experienced an increase in licensing activity, which was largely offset by notable relinquishments in many other countries. Conventional seismic surveys declined throughout the world and the level of exploratory drilling dropped as well, mostly owing to depressed oil prices. With the exception of Latin America where a modest increase in exploratory drilling was largely the result of de-regulation in Argentina, substantial declines occurred, notably in Africa and in Asia and the Pacific. However, development drilling totals increased in most regions as exploration budgets were cut and more resources put into increasing production. 10/

B. Natural gas

31. Natural gas production, reserves and consumption have been increasing significantly and marketed natural gas production now accounts for a substantial part of oil production (see figure IX). World gas reserves have increased faster than those for oil and are now, in equivalent terms, almost as great as world oil reserves. Natural gas is the fastest-growing fuel in many developing countries, especially in dynamic developing economies of Asia and the Pacific region and Latin America. However, the fact remains that the major barrier to development of indigenous natural gas resources in developing countries is the high fixed cost of exploration and production and of establishing the pipeline infrastructure which is specific in its customer and demand profile.

32. With the spread of economic reform in Latin America, natural gas development projects came into sharp focus. Latin America's natural gas reserves already exceed those of North America and further big discoveries are expected, as the region is comparatively underexplored. Cross-border trade in gas is getting a boost from various free trade agreements between countries, and among the gas projects planned for the region are pipelines from Bolivia to Brazil, from Argentina to Brazil, Chile, and Uruguay, and from Venezuela to Colombia.

33. In the past decade, the demand for gas in the Pacific rim countries has more than doubled and the region continues to be the driving force behind the growth in world LNG trade, accounting for over 70 per cent of global trade. Indonesia and Malaysia have increased their LNG production and the Republic of Korea and Taiwan Province of China are rapidly growing markets. China is emerging as one of the most prospectively important regions for gas development with several new discoveries made. The Pacific rim countries with the fastest-growing economies in the world represent one of the most important growth markets for gas. Talk continues on proposals for what could be the most ambitious of gas pipeline projects, namely, the building of a Pan-Asian gas grid, stretching from Sakhalin island in the north of the region down to Australia's north-west shelf in the south (a pipeline grid of about 27,000 kilometres) to provide Australia, Brunei Darussalam, China, Hong Kong, Indonesia, Japan, Malaysia, the Philippines, the Republic of Korea, Taiwan

Province of China and Thailand with pipeline gas supplies. The task is enormous and the ongoing development of individual pipeline systems is a necessary first step towards the larger goal of an integrated regional pipeline grid. Cost limits and the price competitiveness of gas will remain major constraints on having a regional network put into effect for some time. The Asia and the Pacific region is the leading producer of natural gas in the developing world and notably 36 per cent of the production is traded across borders as LNG. None the less, at the present time natural gas accounts for only 7.5 per cent of the regional energy mix, owing to limited infrastructure, the resource base, financial costs and the price of gas versus other fuels.

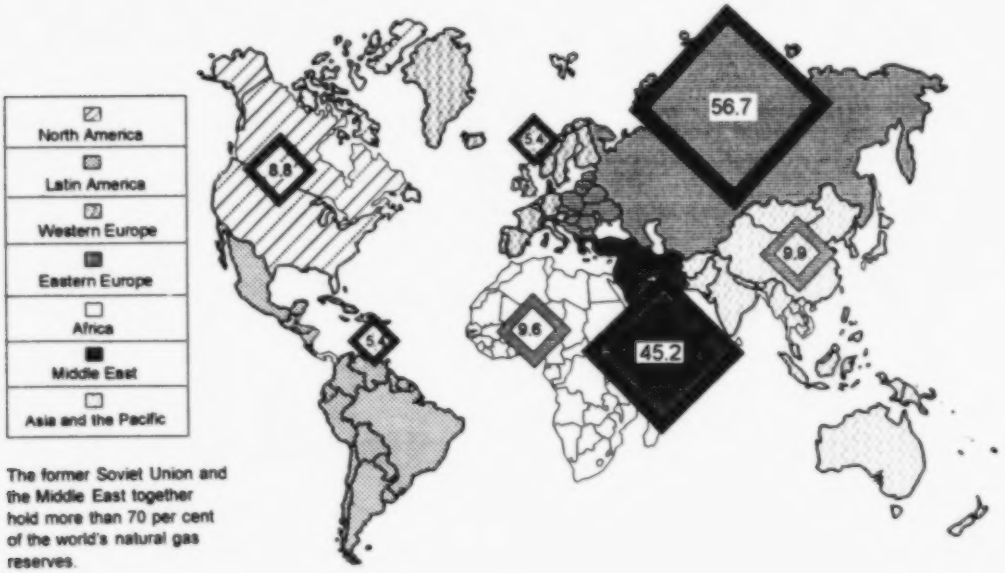
34. LNG exports of Algeria to the United States have increased rapidly, while France remains its largest market. Algeria will also be increasing its pipeline gas supply to Europe considerably, almost doubling the current supply with the completion of two large pipeline projects now under way. Potential LNG supply sources are emerging in a number of countries and several projects are already at fairly advanced stages. Trinidad and Tobago and Venezuela have plans for LNG projects with start-up of deliveries a few years hence. Several projects are under way for developing the gigantic north field in Qatar with supplies slated for Europe and Japan. The Islamic Republic of Iran has plans to develop major gas projects possibly together with Turkmenistan, entailing examining export possibilities to Europe in terms either of a pipeline project or of a combined pipeline/LNG project. The natural gas resources of Turkmenistan are believed to be immense, while the Islamic Republic of Iran currently holds 15 per cent of the world's proved gas reserves.

35. The outlook for natural gas consumption in developing countries is for continued steady growth, given that many of these countries have indigenous gas resources that can be developed or expanded for domestic use, and considering their high electricity demand growth and the economic and environmental benefits of additional gas use (see figure X).

Figure IX. Natural gas proved reserves at end 1994

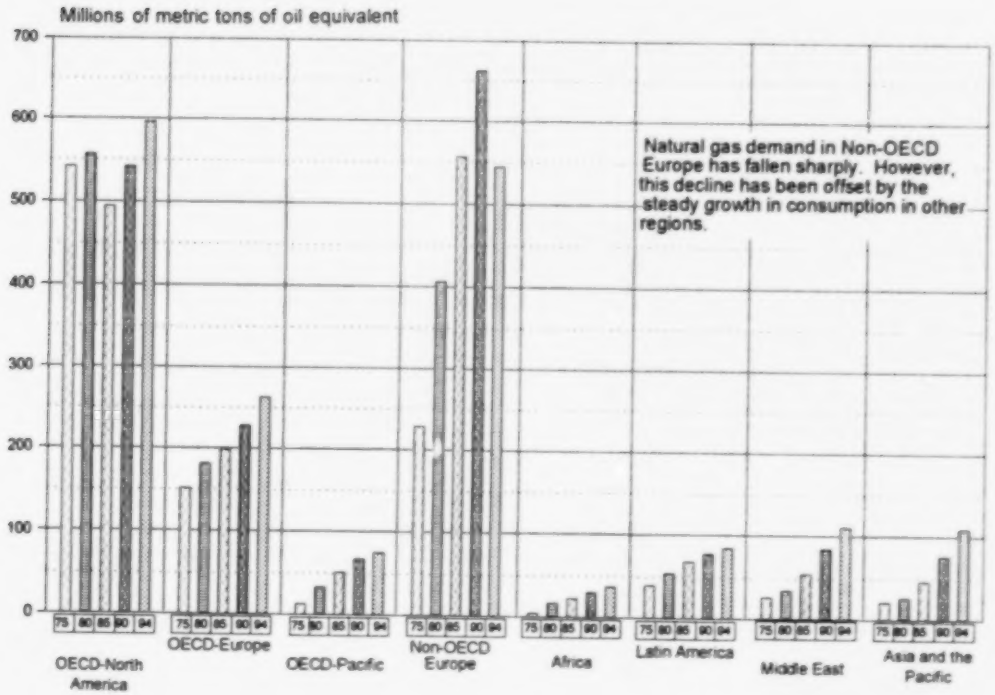
(Trillions of cubic metres)

Total world proved reserves: 141.0 trillion cubic metres (= 953 billion barrels of oil)



Source: Department for Policy Coordination and Sustainable Development of the United Nations Secretariat, based on BP Review of World Gas, 1995.

Figure X. Natural gas consumption by area, 1975-1994



Source: Department for Policy Coordination and Sustainable Development of the United Nations Secretariat, based on Energy Statistics Yearbook (United Nations publication), various issues; and BP Statistical Review of World Energy, June 1995.

C. Coal

36. World wide coal accounts for about 28 per cent of annual primary energy consumption, and demand growth in steaming coal should continue well into the next century. The Asia and Pacific region continues to be the market where the main growth in coal consumption will occur, from the increase in electric power generation, a large share of which will be coal-fired. World wide, coal production is expected to increase in the foreseeable future despite environmental concerns over its mining and use. The traditional leading coal producers, Australia, China, India, Poland, South Africa, the Russian Federation, Ukraine and the United States, will continue to account for 85 per cent of the coal market over that period, while significant growth potential exists in China, Colombia, Indonesia, Venezuela and Viet Nam (see figure XI). World wide, economically recoverable reserves of coal exceed those of oil and gas together and would last for more than 200 years at present levels of consumption (see figure XII).

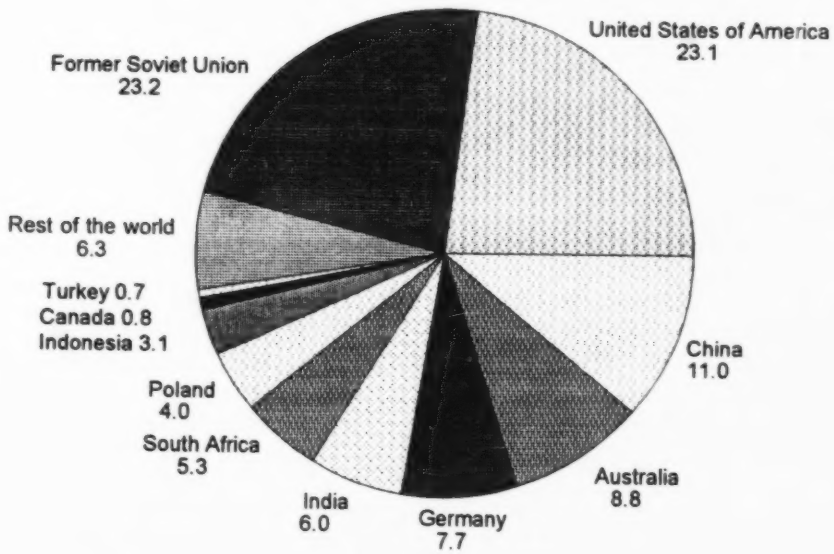
37. Coal will continue to play a significant role as a key source of energy for both developed and developing economies of the world well into the next century, given continuing world economic growth and, with it, an increasing demand for electricity. Coal's key role is in electricity generation, and on average it accounts for almost 40 per cent of the world's electricity production; in OECD countries, it contributes about 32 per cent of the total OECD electricity output.

38. The increasing concern about the impact on the environment of economic activity has highlighted the impacts of coal production and use. OECD countries for the most part have instituted strict standards for mine site rehabilitation, dust abatement in coal handling and tight controls on flue gas emissions. Advanced clean coal technologies are expected to play an increasingly important role in reducing to a minimum the environmental impact of coal use. Developing countries lack the capital to invest in the technology for a clean and efficient use of coal in meeting a growing demand for electricity.

Figure XI. World coal reserves a/ at end 1994

(Percentage of world total)

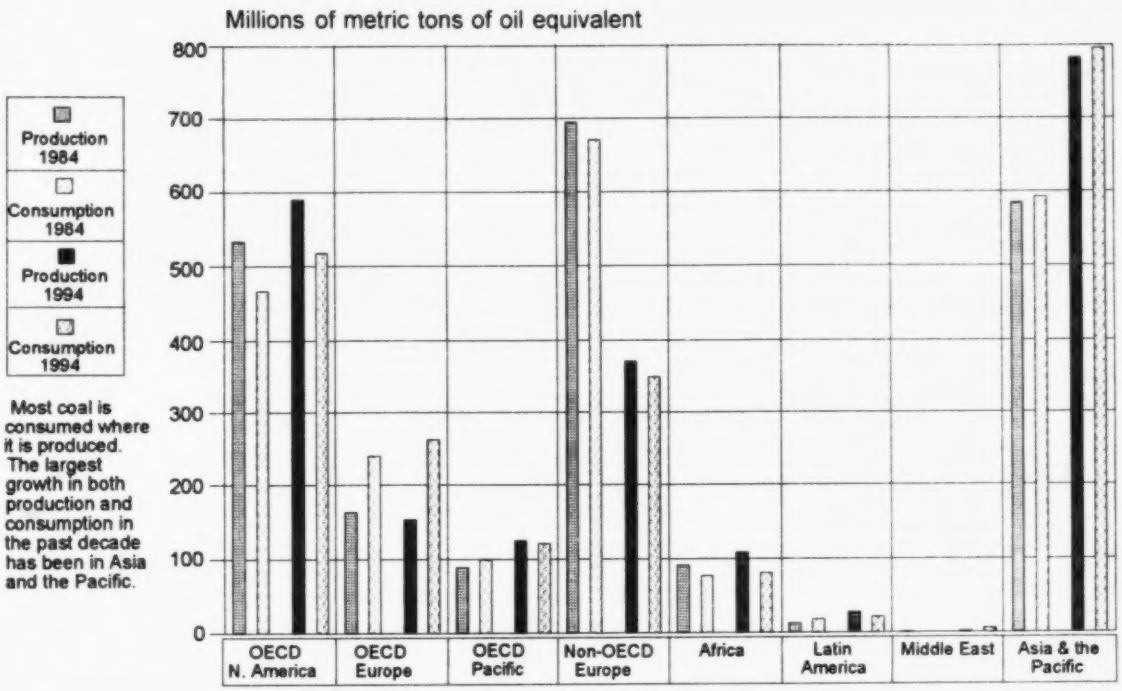
Total world reserves: 1.044 billion metric tons



Source: Department for Policy Coordination and Sustainable Development of the United Nations Secretariat, based on Energy Map of the World, Series No. 2, 4th ed. (London, Petroleum Economist, Ltd., May 1995); and BP Statistical Review of World Energy, June 1995.

a/ Anthracite, bituminous, sub-bituminous and lignite.

Figure XII. Regional production and consumption of coal, 1984 and 1994



Source: Department for Policy Coordination and Sustainable Development of the United Nations Secretariat, based on Energy Statistics Yearbook (United Nations publication), various issues; and BP Statistical Review of World Energy, June 1995.

D. Electric power

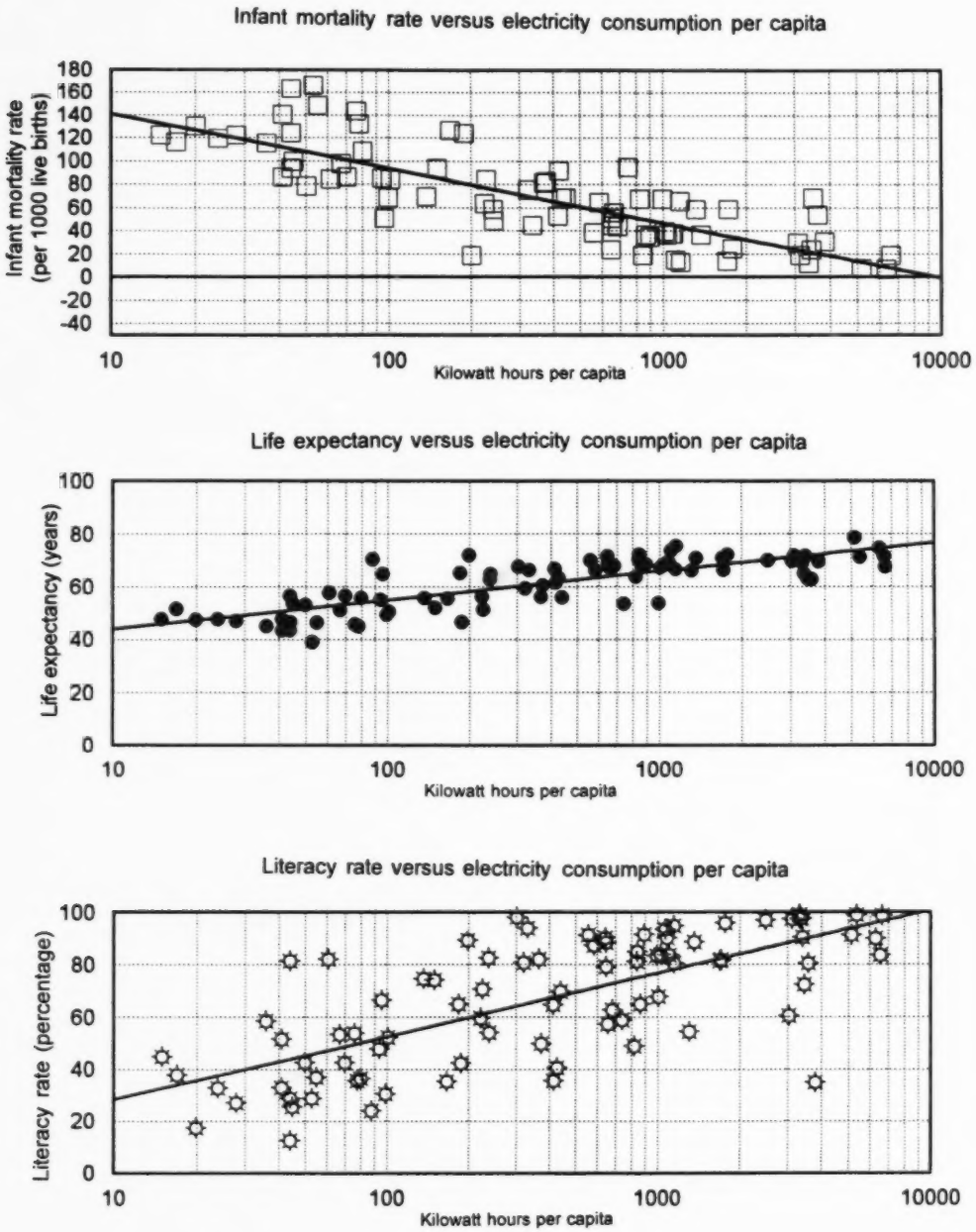
39. Almost without exception, electricity demand in developing countries has been rising rapidly and there is an ever-widening gap between supply and demand, particularly in energy-deficient countries. Electricity has increasingly assumed greater importance in the total energy mix of developing countries, with increasing recognition of adequate and reliable electric power as being central to economic and social development. Interestingly, there are basic differences between the industrialized and developing countries in their increased utilization of electric power. In industrialized countries, demand increases were due to policies encouraging alternate sources of energy and the shift in industrial structure from heavy to lighter, electricity-intensive industry. In most developing countries, increased utilization of electricity was mainly the outgrowth of improving the quality of life of people (by providing them with electricity). Rising per capita income levels and increasing use of electricity (and increasing use of modern fuels as well, for that matter) are unequivocally linked. Not only is electrification closely associated with industrialization but it also contributes significantly to achieving goals of higher standards of living (tangible qualities of life improve; infant mortality declines, there is longer life expectancy and literacy rises to almost the universal level), as is depicted in figure XIII based on data from over 90 developing countries.

40. In the large majority of developing countries, growth in the number of electricity customers was limited and only reached a level determined by the availability of resources for connecting customers into the system. There was also increased consumption per customer, as a growing economy provided consumers with the means to acquire electric appliances for their homes. Foremost among the problems faced by the electricity industry in the developing countries with such high demand growth rates was the constant need for expansion in electricity generation capacity. Failure to provide sufficient capacity to meet demand will involve heavy economic and social costs, as power shortfalls constitute a serious constraint on development.

41. Electricity's share of final energy demand continues to increase world wide and this trend is projected to extend well into the future. Fossil fuels remain the dominant primary energy source for electricity generation. At present, in OECD countries, fossil fuels contribute about 58 per cent of the primary energy converted for electricity generation, hydroelectricity 15.6 per cent, nuclear energy 24 per cent and renewable sources and waste materials the remainder of about 2.4 per cent. In the developing world, thermal powerplants provide the bulk of the electricity supply, except in Latin America where hydroelectricity generation predominates (see figure XIV).

42. The electric power sector of developing countries faces a formidable array of new challenges. There are very strong social imperatives and political pressures to expand the supply, as large segments of the population are typically still without electricity. The problem of meeting demand growth is more acute in those developing countries where the overall macroeconomic situation is poor and the electric power sector also tends to be in the worst condition. The need to incorporate environmental considerations will lead to increased investment costs and may result in higher debt-service obligations.

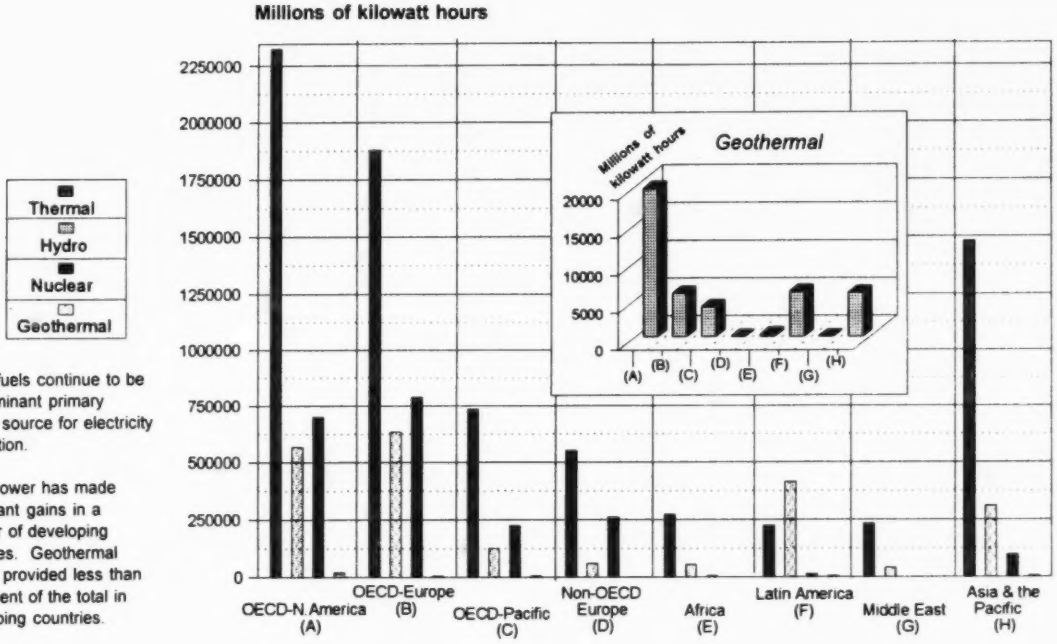
Figure XIII. Physical quality of life and per capita electricity consumption, 1992 a/



Source: Department for Policy Coordination and Sustainable Development of the United Nations Secretariat, based on Energy Statistics Yearbook, 1992 (United Nations publication, Sales No. E/F.94.XVII.9); and United Nations Development Programme, Human Development Report, 1995 (New York, Oxford University Press, 1995).

a/ Data from about 90 developing countries.

Figure XIV. Regional electricity generation by fuel source, 1992



Fossil fuels continue to be the dominant primary energy source for electricity generation.

Hydropower has made significant gains in a number of developing countries. Geothermal energy provided less than 1 per cent of the total in developing countries.

Source: Department for Policy Coordination and Sustainable Development of the United Nations Secretariat, based on Energy Statistics Yearbook, 1992 (United Nations publication, Sales No. E/F.94.XVII.9).

43. Prospects have been improving for grid-connected electricity generation from renewable sources, especially wind power, although it is inherently intermittent, as the technology has improved considerably and costs have declined as a result. There has been significant growth in the use of grid-connected wind turbines in the last few years in some OECD countries, notably Denmark, Germany, the Netherlands, Spain, the United Kingdom and the United States, while in developing countries, little has been done except in China and India and to some extent Egypt, where experimental projects have been carried out to introduce large wind turbines. The degree of the contribution from such sources in developing countries very much depends on site availability. Most developing countries are tropic to subtropical in location; in such areas, in contrast with the temperate latitudes, favourable wind regimes are relatively scarce. However, some island developing States have favourable wind regimes; and Cape Verde has a number of grid-connected wind turbines in operation.

44. The costs of solar systems remain a major barrier to their widespread use in grid-based markets. Photovoltaic (PV) efficiency has been improving significantly, although at present the best efficiency is about 30 per cent. The outlook on photovoltaic electricity is one of optimism as the commercially available efficiency is well below theoretical limits, and the belief is that it should be cost-competitive with conventional-type generation early in the next century. Solar thermal systems, like photovoltaics, tend to be expensive because there is not much demand for them at present and they are therefore not mass-produced. Despite dramatic progress made in the past decade in advancing solar technologies and reducing their costs, most are still not competitive with conventional energy on a direct-cost basis.

45. Many of the renewable energy technologies for electricity generation, such as the solar, wind, wave and tidal forms are, because of their variability, incapable of providing a steady and reliable power supply. Use of batteries and other storage systems can improve the availability of energy from these intermittent sources, but a truly effective way of ensuring a reliable supply will require a power system consisting of a variety of independent electricity generating units capable of working together with spare capacity.

46. Standalone solar PV systems, mostly imported, have found widespread use in developing countries in telecommunication transmission and reception, lighting, small medical refrigerators and water pumping. Several factors restrict enhanced market penetration of PV systems in developing countries, with the main constraint being technology, as local producers are not in a position to service a larger-scale demand.

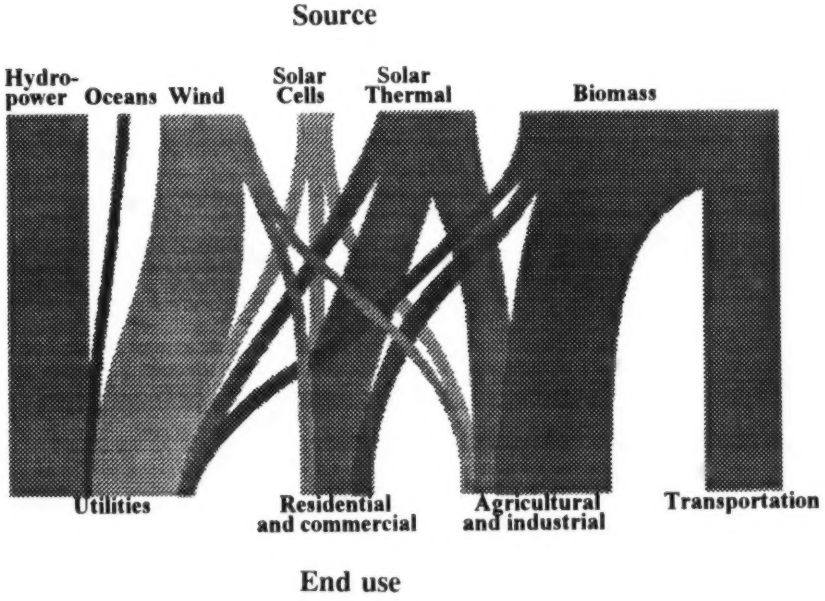
E. Renewable sources of energy

47. Solar electricity and thermal systems, wind power, minihydro turbines, the recycling of waste biomass and biomass digesters for making gas and liquid fuels are a few of the many renewable energy technologies that have enormous potential; but realizing their potential still requires significant research and development for commercialization in developing countries. A likely scenario of the distribution of these renewable energy sources by a date early in the next century (as depicted in figure XV) is one involving different means of tapping resources.

48. At present, biomass provides (and more than likely will provide well into the next century) on average about a third of the total energy supply in developing countries. Consumption patterns range widely, however: biomass constitutes over 90 per cent of the total energy mix in Ethiopia, the United Republic of Tanzania and Nepal but the share is almost negligible in some Middle Eastern countries. 11/ In rural and peri-urban areas of most developing countries, biomass (mostly fuelwood) is often the only accessible and affordable source of energy and mostly serves as an unclean and low-efficiency fuel used mainly in direct burning for cooking and water heating. With growing rural and urban poor populations, demand for biomass will rise, as it is unlikely they will be able to make a rapid transition to cleaner and more efficient fuels. Although the potential biomass resource base is immense and dedicated energy crops could add significantly to that resource base, modern, efficient use of biomass remains to be promoted and applied; a small increase in the efficiency of burning fuelwood would have noticeable effects on carbon and particulate emissions. The value of fuelwood consumed in developing countries as compared with that of electricity and petroleum consumed varies considerably on a regional basis as is seen in table 3.

49. Biomass resources are extremely important to developing countries; however, strategies to enhance the resource base must be planned with the larger developmental context in mind. 12/ As much as there are advantages in increasing the use of biomass, there are serious potential disadvantages as well, especially in developing countries. Not only are there considerable environmental impacts from increased use of these resources, such as negative effects on soil and water availability, but there are also social issues that could arise from growing fuel rather than food crops, thereby further exacerbating food supply problems. In most developing countries, energy plantations with economies of scale will compete with agriculture for the same land resources and inputs, and these countries already lack sufficient land resources to support their populations, given present levels of agricultural inputs. Little is known about the impacts of intensive biomass development on soils and other environmental assets. 13/ Much remains to be done to determine the viability of indigenous species for energy crops, and the research and development on energy crops that are being carried out do not necessarily reflect the needs and conditions of developing countries, particularly since total biomass production will ultimately be limited by land and water availability because of the low efficiency of photosynthesis and the large water requirements for growing plants.

Figure XV. Projected distribution of renewable energy sources in the near term



Source: Department for Policy Coordination and Sustainable Development of the United Nations Secretariat, based on William Hoagland, "Solar energy", Scientific American, September 1995.

Table 3. Fuelwood consumption compared with that of electricity and petroleum in developing countries, 1992

	Africa	Asia and the Pacific	Latin America
Fuelwood			
Quantity (thousands of cubic metres)	480 353	857 668	217 832
Quantity (thousands of tons of oil equivalent)	104 825	187 165	47 536
Total value (millions of US dollars)	13 774	24 593	6 246
(price at US$ 0.13 per kilogram of oil equivalent)			
Electricity			
Quantity (millions of kilowatt hours)	324 481	1 956 084	670 012
Quantity (thousands of tons of ore equivalent)	27 256	164 311	56 281
Total value (millions of US dollars)	48 672	293 413	100 502
(price at US$ 0.15 per kilowatt hour)			
Petroleum			
Quantity (thousands of tons of oil equivalent)	111 630	628 030	289 999
Total value (millions of US dollars)	16 298	91 692	42 340
(price at US$ 18 per US barrel, free on board)			
Total value of fuelwood as percentage of total value of electricity	28.3	8.4	6.2
Total value of fuelwood as percentage of total value of petroleum	96.5	26.8	14.8

Source: Department for Policy Coordination and Sustainable Development of the United Nations Secretariat, based on Energy Statistics Yearbook, 1992 (United Nations publication, Sales No. E/F.94.XVII.9).

50. Electricity production will probably dominate applications of renewable energy technologies, and the most promising near-term application is the hybrid mini-utility system, consisting of a photovoltaic unit, batteries and a diesel generator. An early market for these PV systems exists in developing countries where rural electrification is in its infancy and the extending of power lines to rural areas is often not economical. These mini-utility systems already provide reliable power for some remote applications and are providing service in a number of small island communities; similar systems are being considered for Africa, and for the Australian outback.

51. Depending on favourable wind regimes, one early use of wind energy will most likely be in islands and other areas that are far from electrical grid, and, for reliability, as in the PV system mentioned above, a hybrid system of wind turbine generator, batteries and diesel generator will be used. Except for a few developing countries - China and India with programmes for grid-connected wind turbines and such niche markets as Mongolia with small wind turbines for battery-charging - countries have so far been limited in their use of wind-driven electricity, although there is considerable potential for applying such technology.

V. ENERGY AND ENVIRONMENT IN DEVELOPING COUNTRIES

52. For developing countries, energy use and environmental degradation are seen as being linked in a complex relationship, since energy wisely and efficiently used will provide several important environmental benefits to them. In rural areas, where the majority of the population live, greater energy inputs into agriculture in the form of tractive power, fertilizer and irrigation will substantially improve agricultural productivity which will help slow the expansion of agricultural lands otherwise needed to feed the growing population.

53. The United Nations Framework Convention on Climate Change 14/ recognizes that human activities could alter global climate and commits the signatories to stabilizing greenhouse gas concentrations in the atmosphere at a level that would prevent anthropogenic interference with the global climate system. Given that many of the greenhouse gas emissions are from the energy sector, in the forefront of the agenda of much of the developed world are energy and global warming and consequently what combination of measures and technologies might be pursued by individual countries to reach specific greenhouse gas emissions reduction targets. Considering the scale of the problem, there is no single technology or energy policy that can provide the solution. 15/

54. In primary energy production, supply and use activities, analyses of the full life cycle reveal a wide range and variety of technology and policy measures to reduce associated greenhouse gas emissions, as well as the complex interrelationship between the various technologies and energy and environmental objectives. However, the full potential of these technologies and policy measures may not be realized owing to social, institutional, financial and market barriers to their application. 16/

55. Greenhouse gas emissions reduction is possible through more efficient conversion of fossil fuels, increased use of low-carbon fossil fuels and suppressing of emissions, increased use of renewable sources of energy, decarbonization of flue gases and fuels, and increased use of nuclear energy. In the end-use sector, there is a large potential for energy efficiency improvements in industry, transport and human settlements. The transportation sector, the most rapidly growing source of greenhouse gas emissions, accounts for almost 80 per cent of final consumption of petroleum products in OECD countries and about 46 per cent in developing countries where demand is expected to increase substantially. Given the existing global stock of transport equipment that would limit opportunities for fuel switching, virtually the entire increase in consumption of transport fuels for the next couple of decades will involve petroleum products. None the less, significant reductions in greenhouse gas emissions can be achieved in the transportation sector by improving the efficiency of drive trains, body shape and materials used in all vehicles, as well as by switching to alternative and improved fuels. In these key areas, changes in OECD countries can clearly influence the pattern of demand for transportation services in the developing world.

VI. CONCLUSIONS

56. Energy is a critical factor in sustainable economic and social progress and development and, this being the case, developing countries are concerned about having secure and affordable sources of energy. At the same time, developing countries are aware that they must strive for progressive improvement in environmental performance in their production and use of energy, by reducing waste and emissions through significantly increased efficiency and by moving towards a better energy mix. However, it is also clear to these countries that too rapid a change in their energy supply systems would have an adverse social and economic impact and, moreover, that the need to achieve longer-term energy and environmental balance through improvements in efficiency should not be addressed by way of measures of short-term expediency. In the long run, the only affordable and effective way to reduce the impacts of energy production and use on the environment is to change the products and processes, policies and pressures that generate waste and give rise to pollution. The industrialized nations with their greater resources are better-positioned to make this happen, by setting a good example for developing countries in terms of energy efficiency and environmental protection.

57. Fossil fuels will continue to be dominant in the energy demand structures of both developed and developing countries well into the next century; not before then will competitive alternatives be developed and widely adopted. Much of the additional energy needed to meet the growing demand in developing countries will be supplied by oil and for the energy-deficient countries the incremental demand for oil will have to be met through imports. Many developing countries are already burdened by high oil import bills; therefore any new and additional supply from indigenous energy resources would greatly contribute towards the relief of this burden.

58. A major problem facing most developing countries now, and one they will be facing increasingly in the future, is that of mobilizing the capital necessary to meet their growing energy requirements, against a background of stagnant multilateral loans and grants and falling official development assistance. In several international forums, there have been calls for new steps to increase national and foreign private investment in the energy sector; however, the private sector will not respond to many developing countries, especially to the poorer and thus needier countries, upon perceiving unfavourable economic conditions.

59. Significant progress has been made in a number of OECD countries in the commercial application, albeit a very limited one, of renewable energy technologies that contribute electricity to the utility distribution-line grid, while the fact that in developing countries the demonstration and limited application of these technologies are mostly occurring in a dispersed setting is very likely due to the economics of the technologies concerned. Grid-connected systems require considerably larger financial outlays than those for small-scale, standalone systems.

60. Biomass resources are extremely important to developing countries. However, strategies to enhance the resource base must be planned with the larger developmental context in mind. Special attention must be given to issues like the impact of intensive biomass development on soils and other environmental assets and the viability of the use of indigenous species for energy crops.

Notes

1/ A. A. Churchill, in his presentation "Economic growth: meeting the challenge of increased energy use", at the keynote session of the Executive Conference on Energy Technology Policy for Sustainable Development: Comparing Long-Term Approaches, held at Noordwijk, the Netherlands, 9-11 December 1992, pointed out the need to move away from debates on future problems and focus on resolving the very real problems that developing countries face today. He outlined four major problems that the developing world is encountering today: poverty, the inability to mobilize capital, low efficiency and environmental pollution, all of which are closely linked. He argued convincingly that the challenge before the global community today is to break the link between low incomes and the poor use of energy in developing countries.

2/ See John P. Holdren, "Energy in Transition", Scientific American, September 1990.

3/ The benefits of economic growth in developing countries will be spread over an increasing population, leading to a slower rate of growth in per capita incomes than would be the case if their populations were more stable. The share of the world's population living in developing countries will continue to rise, and is projected to exceed 78 per cent by the year 2010.

4/ Trends in energy investments and financial requirements were summarized in the reports of the Secretary-General on energy exploration and development trends in developing countries and on changing global energy patterns (A/47/202-E/1992/51, sect. IV; E/C.13/1994/2, sect. III; E/1994/75, sect. III). An estimate of the investment requirements for the oil industry as a whole has been put as high as US$ 1,020 billion, of which US$ 250 billion is for exploration and development, US$ 250 billion for refining, US$ 180 billion for ocean transportation and pipelines, and US$ 340 billion for storage, distribution and marketing. In the electricity generating sector, a World Bank study in energy-deficient developing countries, based on plans for generating capacity expansion from about 240,000 megawatts (MW) to about 440,000 MW in 1999, estimated cumulative capital investments at US$ 450 billion, of which US$ 150 billion will be in foreign exchange.

5/ Energy statistics for 1994 in the present report are from BP Statistical Review of World Energy, June 1995; and other energy statistics are based on the Energy Statistics Yearbook (United Nations publication), various issues, and Oil and Gas Journal, various last issues of the year containing the "World production report".

6/ International Energy Agency (IEA), World Energy Outlook (Paris, OECD, 1994).

7/ Technology is mediating a shift away from large, centralized powerplants to smaller, decentralized ones. Improvements in electronic communications, control, and computing technology have made it easier to monitor and regulate complex grids remotely. With gas turbines, small engines, solar cells and other technologies, the economies of scale of electricity generation are diminishing.

8/ Centre for Global Energy Studies, Global Oil Report (London), vol. 6, No. 1 (January-February 1995).

9/ Statistical Yearbook, fortieth issue (United Nations publication, Sales No. E/F.95.XVII.1).

10/ All statistics on petroleum exploration indicators are from World Petroleum Trends 1994 (United Kingdom, Petroconsultants Ltd.).

11/ See Energy Balances and Electricity Profiles, 1992 (United Nations publication, Sales No. E/F.94.XVII.14).

12/ Biomass development and use are discussed in more detail in a sister-document transmitted for consideration by the Committee.

13/ In the report, Fueling Development, Energy Technologies for Developing Countries, by the Office of Technology Assessment of the Congress of the United States (OTA-E-516/517, April 1992), technologies and policies that will enable more efficient use of energy and the most promising new sources of energy supply are examined and energy options and opportunities in the countries of the developing world are also analysed. Its review of many experiences of the United States and other industrialized countries in the energy sector provides valuable insights.

14/ A/AC.237/18 (Part II)/Add.1 and Corr.1.

15/ A report on impacts of energy use on the atmosphere, including guidelines for options in mitigating/abatement of anthropogenic impacts, is being presented in a sister-document for consideration by the Committee. The Committee may also wish to refer to the Second Assessment Report of the Intergovernmental Panel on Climate Change for in-depth analysis of the problem.

16/ The IEA/OECD Scoping Study: Energy and Environmental Technologies to Respond to Global Climate Concerns, 1994, established a basis for discussions on actions that needed to be taken on technology development in order to respond to global climate change concerns, as well as the potential for unilateral efforts and opportunities for international cooperation.